



Heads-Up on a Whale's Gulp

Talk about a mouthful. In one giant gulp, a blue whale—the biggest creature on Earth—takes in 125% of its 150-metric-ton body weight in water and krill. And less than a minute later, it's ready for another bite.

Studying such extraordinary behavior sometimes requires extraordinary measures. At the meeting, paleontologist Nicholas Pyenson of the Smithsonian National Museum of Natural History in Washington, D.C., recounted traveling to a shore-based whaling station in Iceland where he and colleagues cut into carcasses and discovered a new sensory organ in jaws of gulping whales. And a comparative physiologist, Jeremy Goldbogen of the Cascadia Research Collective in Olympia, Washington, described motoring right up to blue whales at sea to attach innovative sensors with radio transmitters on their backs. With colleagues, including a physicist and a computer scientist, he has come up with a detailed accounting of whale feeding bouts, showing how the animals unexpectedly twist as they take in water. The work has also revealed that the energy gained and expended by gulping may help explain why certain whales are as big as they are, and, perhaps, why they are no bigger.

Earlier studies with simpler monitoring tags had revealed how blue whales and other so-called rorqual whales are lunge-feeders. The creatures ram into patches of prey, such as krill, opening their mouths wide and wrapping their jaws around krill-laden water, a move that nearly stops them short because of the ingested weight. The whales then close their mouths and push water through baleen, keratin plates that retain just the food, then

speed up for another feeding bout.

This past summer, Goldbogen monitored several blue and fin whales with new tags, ones that use three-axis accelerometers and magnetometers to detect changes in the whales' orientation in space, much as smart phones do to adjust their displays to a horizontal or vertical position. For the 6 to 24 hours they are attached to the whale, the tags also record depth and sound. (From the loudness of the water rushing past a diving whale, researchers can calculate its speed.) With Colin Ware, a computer scientist at the University of New Hampshire in Durham who specializes in visualizing very large amounts of information, Goldbogen used the tag data to approximate the paths of the whales underwater, presenting each as an animated whale traveling along a ribbon demarking its course. As they gulp, the whales, with surprising agility, often twirl around like a corkscrew, Goldbogen reported at the meeting. They will also lunge into pockets of krill from all different angles, not just horizontally as previously thought.

Goldbogen “could not have explained [what happened] without that additional technology for visualization,” says Michael Dickinson, a neuroscientist at the University of Washington, Seattle.

Goldbogen also teamed up with Jean Potvin, a physicist at St. Louis University in Missouri who studies parachutes—in lunge-feeders, the whale's mouth expands as it gulps water, similar to an opening parachute filling with air. Together with comparative physiologist Robert Shadwick of the University of British Columbia (UBC), Vancouver,

Big gulp. Bryde's whales (left) and other rorqual whales feed by filling their mouths with a body's weight of water and prey.

in Canada, they modeled the physical forces involved in lunge-feeding and from that estimated the energetic costs involved in taking in so much water. They compared those costs with the energy gained from consuming various volumes of krill in blue, fin, and humpback whales. The feeding whale requires up to 15 times the energy required to remain still and five times more than swimming, Potvin reported at the meeting. “At some point there's going to be a limit” on how big a lunge-feeding whale can be and still feed effectively, Goldbogen noted. Potvin's calculations suggest 33 meters—blue whale size—is about at that limit.

Another new insight into lunge-feeding whales came from the whale tissue Pyenson collected in Iceland. He, Shadwick, Goldbogen, and colleagues found a fluid-filled cavity in the chin tissue that connects the two sides of the jaws. After imaging it with MRI and CT scans, Pyenson hypothesized that this whoopee cushion-sized organ helps guide the rotation of the jaws needed during gulping. The cavity has a lot of blood vessels, as well as nerves that came from what was a tooth socket earlier in whale evolution, Pyenson also reported. Inside are fingerlike structures that look like the mechanoreceptors in our skin that sense movement. “To identify such a new sensory structure in a vertebrate is quite remarkable,” says Douglas Altshuler, an integrative biologist at UBC.

Understanding lunge feeding “is a challenging thing to do when dealing with creatures that are a mile deep,” adds David Coughlin, an integrative biologist at Widener University in Chester, Pennsylvania. Goldbogen, Pyenson, and their colleagues “are very creative in trying really novel approaches.” —ELIZABETH PENNISI

Robotic Fish Point To Schooling Gene

Thirty-five years ago, researchers noticed something peculiar about certain three-spined sticklebacks living at the bottom of Paxton Lake in British Columbia, Canada. A tiny fish, this species dwells in both salt and fresh water and typically swims in schools. But the bottom-dwelling Paxton Lake